EVALUATION OF ANNUAL HETCH HETCHY ASSESSMENT TO THE SAN FRANCISCO WATER DEPARTMENT

BROWN AND CALDWELL
CONSULTING ENGINEERS
SAN FRANCISCO-ALHAMBRA, CALIFORNIA

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Evaluation of annual
Hetch Hetchy assessment
1972.

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ENGINEERS

SAN FRANCISCO
ALHAMBRA
EUGENE

WATERWORKS • DRAINAGE
WASTEWATER TREATMENT
RATE STUDIES • VALUATIONS
CHEMICAL AND BIOLOGICAL
LABORATORIES

K. W. BROWN • 1901-1961
D. H. CALDWELL • PE
F. J. KERSNAR • PE
J. C. LUTHIN • PE
T. V. LUTGE • PE

January 5, 1972

Mr. Arthur H. Frye, Jr.
General Manager and Chief Engineer
San Francisco Water Department
425 Mason Street
San Francisco, California 94101

Dear Mr. Frye:

Pursuant to Public Utilities Commission Resolution No. 71-0100 adopted March 23, 1971, Brown and Caldwell has undertaken an expanded water rate study for the San Francisco Water Department.

In accordance with items 1, 2 and 3 of the agreement, an analysis of the Hetch Hetchy Project capital and operating costs was undertaken, and is now completed.

The preliminary report transmitted herewith contains only that portion of the study which relates to the evaluation of the Annual Hetch Hetchy Assessment to the San Francisco Water Department.

On the basis of the cost allocation procedures recommended for the Hetch Hetchy Project, equitable annual assessments to the San Francisco Water Department for Fiscal Years 1972-1973 through 1976-1977 have been developed, and are proposed in this preliminary report.

The size of the Annual Hetch Hetchy Assessments during those five years is significant to the water rate study in progress.

Respectfully submitted,

BROWN AND CALDWELL

By _____
John C. Luthin

By _____
Harris Zoltzew

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CHAPTER 1

INTRODUCTION

At the beginning of this century, in anticipation of San Francisco's future growth, a comprehensive plan was developed for the large scale importation of water from the Tuolumne River.

These early efforts culminated in the Raker Act (H.R. 7207), which granted to the City and County of San Francisco the right to develop the Hetch Hetchy hydroelectric system in Yosemite National Park and Stanislaus National Forest.

The Hetch Hetchy hydroelectric system began the sale of power in 1925, while the delivery of water to the SFWD began in 1934.

In Fiscal Year 1969-1970, the Hetch Hetchy system provided three-quarters of the total quantity of water consumed by SFWD's customers.

For this service, the SFWD is assessed an annual standby charge by the Hetch Hetchy Department. This assessment, which in the past has not been based on the specific quantity of water delivered, has varied each year in accordance with the comparative budget requirements of the two departments.

The operating costs and debt-service costs of the Hetch Hetchy Department are of three kinds: those specifically attributable to the water production functions; those specifically attributable to the power production functions; and those attributable jointly to both functions.

It is the purpose of this report to estimate the near-future water, power and joint cost burdens of the Hetch Hetchy Department; to allocate the joint costs equitably between the water and power functions of the hydroelectric system; and to calculate the required annual assessments to SFWD.

Scope of Study

The scope of the work done in the preparation of this report encompasses the following:

1. Review of reports setting forth the financial results of operation of the Hetch Hetchy system.

2. Review of the recorded revenues and expenses for the past, and those budgeted for the future.

3. Study of the history and operations of the hydroelectric system, to the extent necessary for an understanding of the costs associated with the respective water, power and joint operations.

4. Study of cost allocation procedures employed in other large scale multi-purpose hydroelectric projects.

5. Development of an equitable allocation procedure for the apportionment of joint costs between water and power.

6. Determination of the required annual assessments to the SFWD for the next five years.

7. Preparation of a report of findings and recommendations.

Emphasis on each of the several phases of the work was appropriate to the needs of this study, and some additional work was done as deemed necessary.

Conduct of Study

A major part of the effort for this study was office work, and involved study of existing historical reports and data, reconciling accounts and financial statements, making projections of capital and operating costs, making detailed cost allocations, and determining the required annual assessments to the SFWD.

Numerous meetings were held in the Hetch Hetchy Department offices with department staff members, and the various Hetch Hetchy project facilities were visited and observed. These visits were used to gain an understanding of the department's accounting system, to gather cost data needed for the allocation studies, and to obtain the necessary engineering data relevant to the allocation procedure.

Many sources of information were used in preparing this report. All of the annual reports and statements of the Hetch Hetchy Department were available and were used. Most of the published reports and documents used in the course of the work are listed in Appendix A.

CHAPTER 2

PROJECT HISTORY AND DESCRIPTION

The Hetch Hetchy Project is a dual-purpose, multi-component hydroelectric system producing two vendible commodities: water and power.

The principal features of the project and their primary function in the system are indicated below:

Specific Water Facilities

- Foothill Tunnel
- S.J. Valley Pipeline #1
- S.J. Valley Pipeline #2
- S.J. Valley Pipeline #3
- Coast Range Tunnel

Specific Power Facilities

- Canyon Power Tunnel
- Kirkwood Powerhouse
- Priest Reservoir
- New Moccasin Powerhouse
- Eleanor-Cherry Tunnel
- Cherry Power Tunnel
- Holm Powerhouse
- Early Intake Switchyard
- 115 KV Transmission Lines
- 230 KV Transmission Lines
- Warnerville Substation

Joint Facilities

- Hetch Hetchy Reservoir
- Mountain Tunnel
- Lake Eleanor
- Lake Lloyd
- New Don Pedro Reservoir
- Water Rights, Land and Equipment

Project History

In 1901, the city engineer reported upon alternative long range water supplies, and recommended the Hetch Hetchy project. Steps were taken to appropriate

waters of the Tuolumne under the provisions of California water rights law, and agreement of the United States Department of the Interior was also sought, since the proposed reservoir sites were within Stanislaus National Forest and Yosemite National Park. After six years of negotiation and effort on the part of the city, the necessary permit was granted by Interior Secretary James Garfield in May 1907.

On the basis of the federal permit, the people of San Francisco voted a $600,000 bond issue in 1909 and a $45,000,000 issue in 1910. The Hetch Hetchy Department was set up within the Department of Public Works to carry out the project under the direction of the city engineer.

After revocation by the Department of Interior of portions of the original development permit, the city went to the United States Congress and asked for an act which would make its rights firm. After protracted debate by the Congress and studies by the Army Engineers, Congress passed the Hetch Hetchy grant, known as the Raker Act, in 1913.

In 1909, prior to passage of the Raker Act, the city began development of the Tuolumne River source by purchasing lands and water rights at Hetch Hetchy, the Cherry Basin, and Lake Eleanor.

The Hetch Hetchy project is comprised of two related but separate water systems. The primary system diverts domestic water from the Hetch Hetchy Reservoir to the SFWD, after it passes through the Kirkwood and Moccasin Power Plants. A second system diverts exchange water from Lake Lloyd and Lake Eleanor to the New Don Pedro Reservoir, after it passes through the Holm Power Plant. Exchange water impounded in the New Don Pedro Reservoir is used to satisfy the Raker Act entitlements of the Turlock and Modesto Irrigation Districts, which then permits larger domestic water diversions from the Hetch Hetchy Reservoir.

Under the terms of the Raker Act three power plants have now been included in the development plan, to assist in financing the project and to make the greatest possible use of the water.

The mountain water impounding system includes three major reservoirs: Hetch Hetchy Reservoir on the Tuolumne River, Lake Lloyd on the Cherry River, and Lake Eleanor on Eleanor Creek. The latter two streams are tributaries of the Tuolumne.

Description of Domestic Water System

The Hetch Hetchy Reservoir now provides water to generate electric power at the Robert C. Kirkwood and Moccasin powerhouses, after which the quantities required for SFWD's domestic and suburban water supply are diverted through the aqueduct system to the Bay area, with excess quantities returned to the New Don Pedro Reservoir.

Water released from Hetch Hetchy flows through a series of tunnels and pipelines down the slopes of the Sierras, through the foothills, across the San Joaquin Valley, and through the Coast Range Mountains to the Alameda East Portal, the western terminus of the Hetch Hetchy Project. It then continues via four pipelines, two under and two around San Francisco Bay, with portions diverted through the Crystal Springs by-pass tunnel and connecting pipelines to the northern peninsula and San Francisco consumption areas. The remainder is discharged to Crystal Springs Reservoir.

The water flows 149 miles through this system entirely by gravity. The water is completely enclosed and protected, except at the regulating reservoirs, for the entire distance.

This source now supplies three-quarters of the total consumption in the SFWD service area, and must provide for all future increases, as no additional local production can be made available.

The water discharged to Crystal Springs Reservoir is subsequently delivered to SFWD customers, after treatment at the new San Andreas Filtration Plant.

O'Shaughnessy Dam and Hetch Hetchy Reservoir. The Hetch Hetchy reservoir is the major impounding reservoir in the mountain system. This reservoir collects and stores the runoff from 459 square miles of granite mountains. Built of concrete, the dam is of the arched gravity type.

Upon completion to its initial height in July, 1923, the dam was dedicated and officially named O'Shaughnessy Dam in honor of the chief engineer of the Hetch Hetchy Project. In 1938 the dam was raised 85-1/2 feet and enlarged to its present size. Water impounded totals 360,360 acre-feet. The spillway is of side-channel type with three drum gates, each 65 feet long, installed in 1950 to provide additional storage when the reservoir is full.

Canyon Tunnel and Robert C. Kirkwood Powerhouse. The 149 mile aqueduct, transporting water from Hetch Hetchy to Crystal Springs Reservoir south of San Francisco, starts at O'Shaughnessy Dam. A nine-foot steel pipe from the outlet system passes under the Tuolumne River in concrete encasement and connects to Canyon Power Tunnel. This pressure tunnel on the north side of the river carries water eleven miles to Robert C. Kirkwood Powerhouse at Early Intake. Its design capacity is 500 million gallons of water per day at maximum reservoir elevation. This Canyon Tunnel, added many years after the Hetch Hetchy system was put into operation, was completed in 1965.

The Robert C. Kirkwood Powerhouse itself was completed in 1967.

Water flowing out of the Canyon Tunnel drops to the powerhouse through a steel penstock pipe with a vertical drop of 1,100 feet. The force of the water

turns two vertical-shaft turbines, each in turn driving a generator rated at 33,750 kilowatts. Power is stepped up to 230,000 volts through transformers and transmitted three-quarters of a mile downstream to Intake Switchyard. The power plant, like Dion R. Holm Powerhouse on the Cherry, is operated by remote control from Moccasin Powerhouse several miles to the west.

After leaving the power house, the water is carried through a short tunnel and pipe conduit into the original Mountain Tunnel.

Mountain Tunnel. Water diverted into the aqueduct from the Robert C. Kirkwood Powerhouse, flows through the 19-mile Mountain Tunnel to Priest Reservoir. Designed for a flow capacity of 400 million gallons daily, the tunnel can carry 470 million under maximum flow conditions. The tunnel was used initially only for the operation of Moccasin Powerhouse. When the aqueduct was completed to the Bay Area in 1934, the tunnel became the first stage of the closed system carrying water to San Francisco.

Priest Dam, Reservoir and Power Tunnel. At the west end of the Mountain Tunnel, 19 miles from Early Intake, water enters Priest regulating reservoir, the forebay for Moccasin Powerhouse. Its function is to temporarily store the inflow from the tunnel, which is at a constant rate, and to release water to the powerhouse at a variable rate, depending upon power generation requirements.

The flow is through gates in the central tower and along a mile-long power tunnel leading to the top of the hill above Moccasin.

Steel penstock pipes extend from the west portal of the power tunnel down the slope of Priest Hill, a vertical drop of 1,300 feet.

Moccasin Powerhouse. The original powerhouse on Moccasin Creek was placed in operation in 1925. However, ground was broken in 1967 for the new Moccasin Powerhouse, which became operational in 1969. The new outdoor type plant was designed to operate two generators of 45,000 kilowatt capacity each, and is immediately adjacent to the old building so that the same penstock lines can be used.

Water coming out of the penstock turns two vertical-shaft turbines, each in turn driving a generator. Power from each generator is stepped up to 115,000 volts through transformers, which feed the power into the Moccasin-Newark transmission line for delivery to consumers.

Foothill Tunnel. The aqueduct continues westward from Moccasin in a closed conduit for the next 116 miles to Crystal Springs Reservoir, just south of San Francisco. The first part is a sixteen-mile tunnel through the foothills on the east side of San Joaquin Valley. This tunnel extends from Moccasin to a connection with the San Joaquin Valley pipelines at Oakdale Portal.

Five miles west of Moccasin, the foothill tunnel is broken by the crossing at Red Mountain Bar, which is accomplished by means of an inverted siphon. This crossing is flooded by the waters of the New Don Pedro Reservoir. That portion of the total flow not needed by the SFWD was formerly released at Red Mountain Bar Wasteway into the old Don Pedro Reservoir, prior to completion of the New Don Pedro Dam. Because of the increased lake height behind the New Don Pedro Dam, excess water is now diverted at Moccasin for storage in the New Don Pedro Reservoir.

The Foothill Tunnel, like the Mountain Tunnel, can carry in excess of 400 million gallons a day.

San Joaquin Pipelines. The San Joaquin Valley is crossed by three underground pipelines, which were constructed at various times as the demand for water increased. These pipelines lie within a 100-foot right-of-way, which has space for a future fourth line.

Water is carried in these pipes, under pressure, all the way from the Foothill Tunnel at Oakdale Portal, to the Coast Range Tunnel at Tesla Portal, a distance of 47-1/2 miles. Flow in all three lines is normally regulated by valves at Oakdale Portal.

The first pipeline was started in 1931 and completed a year later. Pipeline No. 2 was completed in 1953, while the third San Joaquin Valley Pipeline was completed in 1968.

Total continuous average daily capacity of the pipelines is approximately 295 mgd. The safe carrying capacity of these lines, plus the impounded local runoff, will provide SFWD with a sufficient supply of water to meet consumer requirements until approximately 1980.

Coast Range Tunnel. The 29-mile section of the aqueduct through the Coast Range Mountains extends from Tesla Portal, south of Tracy, to Irvington Portal in the City of Fremont. It consists of a 25-mile continuous tunnel, and a 3-1/2 mile tunnel. These two segments are connected by a multiple-pipe, inverted siphon a half-mile in length, across the valley of Alameda Creek. Hetch Hetchy Department jurisdiction ends at the Alameda East Portal, and the San Francisco Water Department is responsible for the system beyond that point. Connections are made at this siphon to transport water from the Alameda County sources of the San Francisco Water Department through the Hetch Hetchy Aqueduct.

The Coast Range tunnel, as presently constructed, was not intended to carry 400 million gallons daily, although the Mountain and Foothill tunnels meet this requirement. For economy reasons, the Coast Range Tunnel was built to handle about 275 million gallons. However, the future construction of a fourth San Joaquin Valley Pipeline is expected to result in sufficient increase in head so that the Tunnel will handle 400 mgd.

Description of Exchange Water System

Water stored in Lakes Lloyd and Eleanor is utilized to generate power at Dion R. Holm Powerhouse and to meet all or a major part of the Raker Act priority water release requirements.

(The Hetch Hetchy Reservoir, at times, is operated to produce the balance of Raker Act release requirements not supplied by Lakes Lloyd and Eleanor. In some normal or better years, the generally higher Raker Act requirements during the spring runoff months can most efficiently be met by releases from Hetch Hetchy Reservoir, due to the fact that the natural water supply in these years is sufficient in the late runoff months to replenish these added storage drafts. Relatively accurate runoff forecasts can be made in March or April, which permits this practice.)

Water released from Lake Lloyd and Lake Eleanor flows through tunnels and natural stream beds until it reaches the New Don Pedro reservoir. This water plus watershed runoff and the controlled releases from the Hetch Hetchy reservoir and aqueduct, is stored in the Don Pedro reservoir, and is used to satisfy the Raker Act entitlement of the Turlock and Modesto Irrigation Districts.

Lake Eleanor. To provide power for early construction requirements, a small hydroelectric plant was built at Early Intake on the Tuolumne River about twelve miles downstream from Hetch Hetchy. To get water to operate this first powerhouse, a multiple-arch concrete dam was built to store 27,100 acre-feet of water at Lake Eleanor.

The Early Intake Powerhouse began operation in 1918 and ceased operation in 1960.

In 1960 a mile-long tunnel was driven through the ridge between Lake Eleanor and Lake Lloyd, enabling runoff from Eleanor watershed to supplement storage in the Cherry system.

Cherry Valley Dam and Lake Lloyd. In addition to Hetch Hetchy and Lake Eleanor, a third impounding reservoir was also authorized by the Raker Act.

This additional storage had been planned to provide for expanding water supply needs and to develop additional electric power resources.

Completed in 1956, the Cherry Dam is a composite earth and rock embankment 2,600 feet long. Water is released through a six-mile power tunnel to a penstock above Dion R. Holm Powerhouse on the Cherry River near its confluence with the Tuolumne.

The 268,800 acre-foot reservoir formed behind Cherry Valley Dam which was named in honor of Harry E. Lloyd provides storage for conservation and power generation. However, the impounded water is not diverted directly to San Francisco's domestic water supply.

Releases from Lake Lloyd are used for power generation at Dion R. Holm Powerhouse and for meeting down-stream irrigation priorities under the Raker Act, thereby preserving storage in Hetch Hetchy Reservoir for SFWD's requirements.

Dion R. Holm Powerhouse. The largest power plant in the Hetch Hetchy system is the Dion R. Holm Powerhouse. This powerhouse was completed in 1960 on the Cherry River, six miles downstream from Cherry Valley Dam. Runoff from Cherry River watershed, together with water diverted from Lake Eleanor, is used to operate this plant. A six-mile pressure tunnel leads from the reservoir to a single steel penstock, through which the water drops down the mountainside to the powerhouse. Inside the powerhouse are two vertical-shaft turbine-driven generators, each with a rating of 67,500 kilowatts. Voltage is stepped up to 230,000 volts for transmission one and a half miles to Intake Switchyard, where power from the nearby Robert C, Kirkwood plant also joins the system.

Water passing through Dion R. Holm Powerhouse discharges into Cherry River and continues down the Tuolumne River to the New Don Pedro Reservoir, operated by the Turlock and Modesto Irrigation Districts.

New Don Pedro. Extensive studies of the development and conservation of the waters of the Tuolumne revealed a number of mutual interests. San Francisco desired additional storage capacity in the mountains to assure its ultimate 400 mgd water supply. The Turlock and Modesto Irrigation Districts in the valley desired additional storage to provide for increasing irrigation use, to minimize water shortage in dry years, and to increase electric power generation. The U. S. Army Corps of Engineers was interested in providing protection from flood damage along the lower Tuolumne and San Joaquin Rivers.

Under a cooperative agreement, the Modesto and Turlock Irrigation Districts constructed a new dam about a mile and a half downstream from their old Don Pedro Dam, creating a storage reservoir with a total capacity of over two million acre-feet.

San Francisco's participation in the project, currently estimated at $52,800,000, was authorized by the approval of the 1961 Municipal Water System Bond Issue. This new reservoir provides the City with exchange water storage space of 570,000 acre-feet, plus half of that portion of the 340,000 acre-feet of flood control space not reserved for the purpose at any given time.

The increase in exchange water storage capacity will enable SFWD to obtain its estimated ultimate requirement of 400 mgd, (as compared to prior capacity of 215 mgd), without building additional storage higher in the mountains.

Also, the additional exchange water impounded will improve the City's power revenues by permitting an estimated 8.3 percent average increase in the output of its existing hydroelectric plants, per Table 3-1.

Description of Power Transmission System

The Hetch Hetchy project also includes about 165 miles of high voltage transmission lines. These are used to convey electrical power to points of delivery to the Modesto and Turlock Irrigation Districts, and into the Pacific Gas and Electric Company system. Power is delivered to San Francisco and to the city's power customers by PG&E Co. under a power "wheeling" agreement.

Power Transmission Lines. The City does not own a municipal electric distribution system, but delivers the bulk of its energy, at transmission voltages, to other agencies for direct sale or for transporting to the City's municipal loads and customers under contractual agreements.

Since July 1, 1945, contracts for the disposal of electric energy have been in effect which conform to the provisions of the Raker Act, as interpreted by the Secretary of the Interior and by the Courts.

Electric energy generated by Hetch Hetchy power plants is carried to points of delivery over two high voltage transmission systems, normally operated independently of each other. These two circuits are interconnected with the electric power systems of Turlock Irrigation District, Modesto Irrigation District, and the Pacific Gas and Electric Company.

From Moccasin Powerhouse Switchyard electric energy is carried over the Moccasin-Newark line to the Newark Substation of Pacific Gas and Electric. Built in 1924-25, the line operates at 115,000 volts for a distance of 98-1/2 miles. This line generally follows the same right-of-way as the water tunnels and pipelines, as far as Tesla in the Coast Range.

The power from Dion R. Holm and Robert C. Kirkwood powerhouses leaves Intake Switchyard on another transmission line, at 230,000 volts. It carries the power 48 miles, by way of Moccasin, to Warnerville Substation near Oakdale. Here the voltage is reduced to 115,000 for further transmission over a 12-1/2 mile line to Oakdale Substation of the Turlock District and Station "J" of the Modesto District. Warnerville also serves as a point of interconnection with the 230,000 volt system of Pacific Gas and Electric.

CHAPTER 3

EFFECT OF NEW DON PEDRO RESERVOIR ON PROJECT POWER OPERATIONS

In a report dated March 29, 1961, prepared for the City and County of San Francisco, the Bechtel Corporation analyzed the effect that the New Don Pedro Reservoir would have on the hydroelectric generation of the Hetch Hetchy Project.

The purpose of the study was to compare the total hydroelectric generation of the Hetch Hetchy Project under conditions that would exist without the New Don Pedro Reservoir, as compared to the total hydroelectric generation from the same three plants after the construction of the New Don Pedro Reservoir.

The study specifically covered the determination, on a monthly basis, of the theoretical power that would be generated at the Holm, Kirkwood and Moccasin power plants during a repetition of the hydrologic conditions that actually prevailed during the prior forty-two year period, November, 1917 through December, 1959. The computed natural flows of the various streams during this period were prepared and furnished by the staff of the City and County of San Francisco.

Subsequent to this study, the old 70,000 kilowatt Moccasin power plant was replaced by the new 90,000 kilowatt Moccasin power plant, and the results of this study therefore require appropriate adjustment.

Hetch Hetchy Project Operation Without the New Don Pedro Reservoir

For the purpose of the Bechtel study it was assumed that Holm, Kirkwood and Moccasin power plants, with a then total rated peaking capacity of 317,000 kilowatts, would be in operation along with Hetch Hetchy Reservoir and Lakes Lloyd and Eleanor. The storage projects would be operated in accordance with the Raker Act to: (1) provide the required domestic water diversion to the San Francisco Water Department, (2) provide flood control reservations in accordance with the then existing contract between the City and County of San Francisco, the Turlock and Modesto Irrigation Districts and the Corps of Engineers, and (3) generate hydroelectric power consistent with the criteria imposed by (1) and (2) above.

The amount of power which would be generated was computed for the two limiting assumptions: (1) that required flood control releases could be reasonably forecasted and therefore pre-released to the maximum extent at rates not exceeding power plant hydraulic capacity; (2) that flood control releases could not be forecasted and must be released at rates far exceeding plant hydraulic capacity and therefore could not be used to produce hydroelectric energy.

These two assumptions embrace the range from maximum to minimum of expected power generation from flood control releases.

Hetch Hetchy Project Operation with the New Don Pedro Reservoir

The New Don Pedro Reservoir, with a total storage capacity of 2,030,000 acre-feet provides a maximum flood control reservation of 340,000 acre-feet. According to the existing contract between the City, the Irrigation Districts and the Corps of Engineers, the flood control operation previously required by the Hetch Hetchy Project will be transferred to New Don Pedro Reservoir. In addition, the City has obtained exchange storage in the New Don Pedro Reservoir of 570,000 acre-feet which can be used to satisfy Raker Act requirements, thus permitting the City to increase its upstream diversion and water storage during the high flow period and hence increase its release from storage during the low flow season. This increased flexibility of regulation together with the elimination of reservoir space for flood control will result both in an increase in hydroelectric power production and an increase in the permissible diversion to San Francisco from the former limit of 215 mgd to the required ultimate supply of 400 mgd.

To evaluate the specific effect of the New Don Pedro Reservoir on Hetch Hetchy power production, operational studies of the entire Tuolumne River System previously performed for the Turlock and Modesto Irrigation Districts on an IBM-704 electronic computer were utilized with only minor modification, based upon a diversion for municipal supply of 400 mgd.

Comparison of Power Generation With and Without New Don Pedro Reservoir

The computed power generation at the City's Holm, Kirkwood and Moccasin Power Plants with and without New Don Pedro Reservoir was summarized in the Bechtel report on an annual basis for the 42-year period from 1917 to 1959. The results of those studies are compared in Table 3-1.

Table 3-1. Summary Comparison of Hetch Hetchy Power Generation with and without New Don Pedro Reservoir, (MWH annually), Before New Moccasin Powerhouse

Description	Without New Don Pedro Reservoir	With New Don Pedro Reservoir	Increase	Percent Increase
Maximum[a]	1,759,000	1,883,000	124,000	7.0
Minimum[b]	1,717,000	1,883,000	166,000	9.6

[a] Forty-two year average, assuming maximum use of required flood control releases
[b] Forty-two year average, assuming minimum use of required flood control releases

It appears that the New Don Pedro Reservoir will increase the City's average annual power generation by 124,000 to 166,000 MWH, (7.0 percent to 9.6 percent), depending upon the accuracy with which flood control releases can be anticipated and utilized.

The average annual increase in Hetch Hetchy power generation attributable to New Don Pedro, before adjustment for the New Moccasin Powerhouse, has been assumed to be midway between the maximum and the minimum estimated increase or 145,000 Mwh, (8.3 percent).

Adjustment for New Moccasin Powerhouse

Since the replacement of the old Moccasin Powerhouse, the total rated peaking capacity of the system was increased from 317,000 kilowatts to 339,000 kilowatts.

The effect of the new Moccasin Powerhouse has been to increase the total annual system electrical generation capability from 1,883,000 Mwh to 1,943,000 Mwh, (three percent), as indicated in Table 3-2.

Table 3-2. Current Power Plant Capacity

Plant	Nameplate rating (kilowatts)	Peaking capability (kilowatts)	Average annual generation (MWH)
Moccasin Powerhouse	90,000	104,000	548,000
Dion R. Holm Powerhouse	135,000	150,000	775,000
Robert C. Kirkwood Powerhouse	67,500	85,000	620,000
Total	292,500	339,000	1,943,000

The average annual increase in Hetch Hetchy power generation attributable to New Don Pedro must therefore also be increased by three percent, (1.03 x 145,000 Mwh), to 150,000 Mwh.

Additional Power Benefits

In addition to making possible a greater total annual power generation, use of exchange storage in New Don Pedro Reservoir also provides greater flexibility in operation of the City's power plants, and permits increased production of peaking power.

Since peaking power is normally more valuable than base-load power, the average unit value of power generated will therefore be increased.

CHAPTER 4

FINANCIAL STATEMENTS AND RESULTS OF OPERATIONS FOR FISCAL YEAR 1969-1970

A summary of the financial status of the Hetch Hetchy Project, as of June 30, 1970, is indicated by the financial statements and exhibits contained in this chapter.

Balance Sheet

The balance sheet for the Hetch Hetchy Project as of June 30, 1970 is shown on pages 15, 16 and 17.

The investment in the new Don Pedro Project, which currently totals approximately $52,800,000, was not yet capitalized as of June 30, 1970.

Income Statement

The income statement for the Hetch Hetchy Project for the twelve months ended June 30, 1970 is shown on page 18.

In this income statement, the joint project costs have been allocated 20 percent to water and 80 percent to power, in accordance with the cost allocation procedure adopted in 1956 per P.U.C. Resolution No. 16,784.

However, this income statement excludes all Muni Transit Overhead Lines expenses, which totalled approximately $750,300 in fiscal year 1969-1970.

Total Actual Expenditures in Fiscal Year 1969-1970

The total recorded actual cash expenditures, encumbrances, and unencumbered funds allocated for subsequent construction, have been detailed in Table 4-1.

Table 4-1. Hetch Hetchy Water and Power

Total Expenditures, Fiscal Year 1970

Description	Amount, dollars
Purchased power and energy	302,833
Wheeling charges	2,273,140
Transmission line rentals	54,000
Taxes	322,828
Fee to U.S. Government	30,000
Operation and Maintenance expense[a]	2,354,109
Sub total	5,336,910
Equipment	74,213
Additions and betterments[a]	286,080
Reconstruction and replacements[a]	321,172
Bond interest and redemption	9,200,437
Sub total	9,881,902
Total	15,218,812

[a] Excludes muni transit overhead lines expenses totalling $750,300, and $1,000,000 budgeted for muni transit additions and betterments and reconstruction and replacements

BALANCE SHEET
JUNE 30, 1970

ASSETS AND OTHER DEBITS

Utility Plant		
Electric plant in service	70,969,431	
Less reserve for depreciation	14,572,376	56,397,055
Water plant in service	91,200,681	
Less reserve for depreciation	37,042,023	54,158,658
Joint plant in service	51,495,359	
Less reserve for depreciation	16,445,226	35,050,133
Other physical property		409,634
Construction work in progress:		
1955 Hetch Hetchy power bond fund	46,994	
1961 Municipal Water System bond fund	161,986	
Hetch Hetchy operating	8,767,301	8,976,281
Total utility plant		154,991,761
Current and Accrued Assets		
Cash	13,206,734	
Accounts receivable	2,154,957	
Interfund receivables	353,441	
Materials and supplies	44,219	
Pre-payments	6,021	
Total current and accrued assets		15,765,372
Investments		
Investment in New Don Pedro Dam[a]		43,939,549

(continued)

Assets and Other Debits (Continued)

Deferred Debits		
Preliminary surveys and investigations	25,917	
Clearing accounts - unbilled orders	354,039	
Damage claims - Contra	100,000	
Advance orders for work - Contra	568,861	
Advance to New Don Pedro Dam[a]	6,420,614	
Budget allocations to other departments	761	
Work in progress	0	
Miscellaneous	216	
Automotive clearing accounts	0	
Commitment liability	1,407,434	
Total deferred debits		8,877,842
Total Assets and Other Debits		223,574,524

[a] Investment in New Don Pedro Reservoir not yet capitalized

LIABILITIES AND OTHER CREDITS

Long-term debt		
Bonds		88,651,018
Current and accrued liabilities		
Accounts payable	1,042,466	
Interfund payables	34,297	
Matured long term debt	27,000	
Matured interest	21,354	
Accrued interest	1,445,015	
Total current and accrued liabilities		2,570,132
Deferred credits		
Deferred credits - suspense credits	7,500	
Deferred credits - claims	0	
Damage claims - Contra	100,000	
Advance orders for work receivable - Contra	568,861	
Advance orders for work - cash advance	108,121	
S.F.W.D. - standby charges	0	
U.S. Government grant	2,221,514	
Commitment liability	1,407,434	
Total deferred credits		4,413,430
Reserves		
Reserve for compensation insurance	15,000	
Reserve for overhead	218,543	
Reserve for cancelled warrants	318	
Total reserves		233,861
Surplus		
1955 Hetch Hetchy power bond fund	2,997,236	
1961 Municipal Water System bond fund	50,584,245	
Hetch Hetchy water and power	74,124,602	
Total surplus		127,706,083
Total Liabilities and Other Credits		223,574,524

INCOME STATEMENT
TWELVE MONTHS ENDED JUNE 30, 1970

Operating revenues	Power	Water	Total
Sale of electric energy	14,090,231		14,090,231
Sale of water - S.F.W.D.		2,500,000	2,500,000
Total operating revenues	14,090,231	2,500,000	16,590,231
Operating revenue deductions [a]			
Purchased power and energy	302,833		302,833
Wheeling charges	2,273,140		2,273,140
Transmission line rentals	54,000		54,000
Operating expenses	920,302	205,718	1,126,020
Maintenance expenses	1,043,233	184,857	1,228,090
Depreciation	1,572,079	1,668,331	3,240,410
Taxes	129,131	193,697	322,828
Fee to United States Gov't.	24,000	6,000	30,000
Total operating revenue deductions	6,318,718	2,258,603	8,577,321
Utility operating income	7,771,513	241,397	8,012,910
Other income			
Miscellaneous non-operating revenues	87,797	21,949	109,746
Gross income	7,859,310	263,346	8,122,656
Income deductions			
Interest on long-term debt	880,073	662,787	1,542,860
Net Income	6,979,237	(399,441)	6,579,796

[a] Excludes muni transit overhead lines expenses totalling $750,300

As noted, these total actual expenditures exclude Muni Transit Overhead Lines expenses totalling $750,300, as well as $1,000,000 allocated for replacement of the Muni Transit direct current distribution system.

Sources and Application of Funds

The total recorded revenues realized in fiscal year 1969-1970, by specific function, have been indicated in Table 4-2.

Table 4-2. Hetch Hetchy Water and Power Operations, Sources and Application of Funds, Fiscal Year 1970[a]

Description	Power	Water	Joint	Total
Revenues				
Power	14,090,200	0	0	14,090,200
Water		2,500,000	0	2,500,000
Miscellaneous	87,800	21,900	0	109,700
Total	14,178,000	2,521,900	0	16,699,900
Less:				
Wheeling charges	(2,273,200)	0	0	(2,273,200)
Purchased power	(302,800)	0	0	(302,800)
Line rental	(54,000)	0	0	(54,000)
Total	(2,630,000)	0	0	(2,630,000)
Net revenue available	11,548,000	2,521,900	0	14,069,900
Expenditures				
Operating expenses	1,112,300	177,900	1,093,900	2,384,100
Taxes	0	0	322,800	322,800
Equipment, additions and betterments, reconstruction and replacements	35,000	0	646,500	681,500
Bond interest	805,800	986,600	1,520,000	3,312,400
Bond redemption	3,085,000	1,457,700	1,345,300	5,888,000
Total	5,038,100	2,622,200	4,928,500	12,588,800
Allocations of joint expenditures				
Operating expenses	729,300	364,600	(1,093,900)	0
Taxes	129,100	193,700	(322,800)	0
Equipment, additions and betterments, reconstruction and replacements	419,500	227,000	(646,500)	0
Bond interest	456,000	1,064,000	(1,520,000)	0
Bond redemption	403,600	941,700	(1,345,300)	0
Total	2,137,500	2,791,000	(4,928,500)	0
Total Expenditures	7,175,600	5,413,200	0	12,588,800
[a] Surplus (deficit)	4,372,400	(2,891,300)	0	1,481,100

[a] (Excludes $1,750,300 expended for muni transit overhead lines)

In addition, each of the expenditures previously detailed in Table 4-1 has been distributed by specific function, (power, water or joint), in Table 4-2. Those expenditures identified as joint have, in turn, been allocated between water and power in accordance with the allocation procedures recommended in Chapter 6.

Expenditures totalling $1,750,300 for Muni Transit Overhead Lines have been excluded from Table 4-2.

On the basis of the proposed allocation procedures, Hetch Hetchy water operations incurred a deficit of $2,891,300 in fiscal year 1970.

CHAPTER 5

ANNUAL DELIVERIES OF WATER, AND ANNUAL WATER ASSESSMENT, TO SFWD

The Hetch Hetchy Department began the delivery of water to SFWD in 1934.

In Fiscal Year 1969-1970, the Hetch Hetchy system provided three-quarters of the total quantity of water consumed by SFWD's customers.

For this service, the SFWD is assessed an annual standby charge by the Hetch Hetchy Department. This assessment, which in the past has not been based on the specific quantity of water delivered, has varied each year in accordance with the comparative budget requirements of the two departments.

SFWD Sources of Supply

The SFWD produces or imports water from a variety of local sources in Alameda, Santa Clara and San Mateo Counties, but the principal source by far is importation from Hetch Hetchy.

Table 5-1. Hetch Hetchy Deliveries and Assessments to S.F.W.D.

Fiscal year	Delivery to SFWD, (acre-feet)	Annual assessment to SFWD, dollars	Net revenue per acre-foot, dollars
1961	162,434	4,500,000	27.70
1962	175,474	4,600,000	26.21
1963	140,370	5,000,000	35.62
1964	147,879	4,500,000	30.43
1965	167,900	4,500,000	26.80
1966	169,374	5,800,000	34.24
1967	208,306	2,500,000	12.00
1968	183,895	3,500,000	19.03
1969	204,798	2,500,000	12.21
1970	205,798	2,500,000	12.15
Total	1,766,228	39,900,000	22.59

In Fiscal Year 1969-1970 the total water consumption in the SFWD system equaled 278,731 acre-feet, while Hetch Hetchy deliveries to the SFWD amounted to 205,798 acre-feet, or 74 percent.

Hetch Hetchy Deliveries and Assessments

The total quantity of water delivered to SFWD over the decade 1961-1970 equalled 1,766,228 acre-feet.

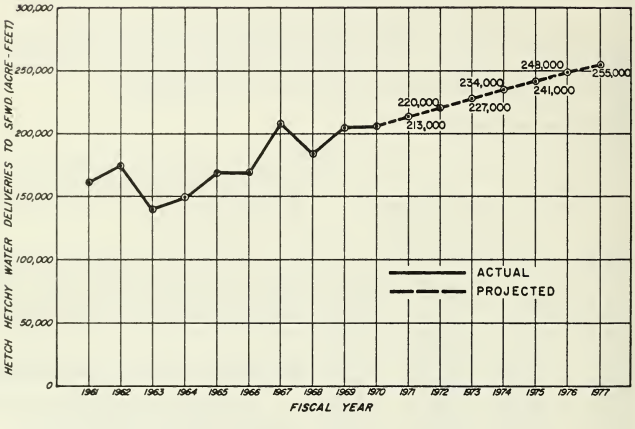
The total assessment to the SFWD during this same period amount to $39,900,000, or $22.59 per acre-foot.

The annual deliveries and assessments during this ten year period have been summarized in Table 5-1.

Projected Hetch Hetchy Deliveries to SFWD

On the basis of current projections of demand for the SFWD service area, deliveries are expected to increase in the immediate future at the average rate of 7,000 acre-feet per year, as indicated in Fig. 5-1.

Fig. 5-1. Projected Annual Deliveries of Hetch Hetchy Water to SFWD



CHAPTER 6

ALLOCATION OF COSTS BETWEEN WATER AND POWER FUNCTIONS

The Hetch Hetchy Project is a dual-purpose, multi-component hydroelectric system producing two vendible commodities: water and power.

The principal features of the project and their primary functions in the system were indicated on page 3. Each facility is either utilized specifically for water production or for power generation, or is used jointly for both project purposes.

For the past fifteen years, in accordance with Public Utilities Commission Resolution No. 16,784 dated October 29, 1956, joint capital and operating costs of the Hetch Hetchy Project have been allocated 80 percent to Power and 20 percent to Water.

However, it no longer appears reasonable to allocate joint costs on that basis, and it is proposed that the "proportional benefits" method of allocating joint costs of multiple-purpose water resource projects be adopted instead.

Hetch Hetchy Project Cost Allocations

The principle that power users should subsidize municipal water users is not incorporated in the Raker Act and has not been the policy of the City and County of San Francisco. Instead, the policy has been that the beneficiaries of the Hetch Hetchy Project should each repay their fair share of the project costs.

The 1966-1967 Annual Report of the Hetch Hetchy Water and Power System (p.2) states: "As a by-product of the water supply function, electrical energy is generated at City powerhouses on the Hetch Hetchy Project.....Power revenues of Hetch Hetchy are applied to reduce the cost of delivered water."

Although power generation significantly reduces the cost of delivered water, it does so not in the form of a direct subsidy, but by virtue of absorbing a substantial share of the joint capital costs and joint operating costs that would otherwise be borne by SFWD water users alone. In most instances, the addition of a second purpose to a water project facility is economically advantageous to both project purposes. The development of electric power generation is therefore of considerable assistance in achieving economic water delivery.

An equitable annual assessment to the San Francisco Water Department should therefore not produce revenue in excess of or less than the remaining costs for operation, maintenance, additions, replacements, bond interest and bond

redemption, after the full power share of these costs have been distributed.

For the past fifteen years, in accordance with Public Utilities Commission Resolution No. 16,784 dated October 29, 1956, joint capital and operating costs of the Hetch Hetchy Project have been allocated 80 percent to Power and 20 percent to Water, as follows:

Final Two Paragraphs of Public Utilities Commission Resolution No. 16,784:

BE IT FURTHER RESOLVED, That beginning July 1, 1956, and continuing thereafter such time as a reappraisal of property value and probable useful life shall be made, pursuant to Section 128 of the Charter, capital and annual expense shall be recorded in the books of account for the Power and Water Division, based on an allocation of joint plant capital and joint operating expense in the proportion of 80% to Power and 20% to Water, and

BE IT FURTHER RESOLVED, That following each reappraisal of property value and probable useful life, determination of capital and annual expense for each division shall be based on the results of such reappraisal in accordance with the procedure herein approved and adopted.

This was the result of an allocation study included in Mr. R. A. Wehe's August 1, 1955 report, based on an analysis of the Project for fiscal year 1952-1953.

However, the configuration of the Hetch Hetchy Project has changed substantially since that time, as detailed below.

The following major components of the Hetch Hetchy Project, still in use today, were in existence prior to August 1, 1955:

Foothill Tunnel
San Joaquin Valley Pipeline #1
San Joaquin Valley Pipeline #2
Coast Range Tunnel
Priest Reservoir
115 KV Transmission Lines
Hetch Hetchy Reservoir
Mountain Tunnel
Lake Eleanor

However, the following major developments have occurred since that date:

October, 1955	Cherry Dam (Lake Lloyd) dedicated
January, 1959	Cherry Power Tunnel holed through
May, 1959	Eleanor-Cherry Tunnel holed through
August, 1960	Holm Powerhouse completed
August, 1960	Early Intake Switchyard operational
August, 1960	230 KV Transmission Lines operational
August, 1960	Warnerville Sub-Station operational
August, 1960	Early Intake Powerhouse shut down
June, 1964	Canyon Power Tunnel holed through
March, 1967	Kirkwood Powerhouse completed
March, 1968	San Joaquin Pipeline No. 3 completed
January, 1969	New Moccasin Powerhouse completed
June, 1971	New Don Pedro Reservoir completed

In view of the extensive changes that have occurred since 1955, the continued allocation of joint costs on the basis of 80 percent to Power and 20 percent to Water no longer appears relevant.

Extent of Project Joint Costs

The total original cost of the project was approximately $275,000,000, as of June 30, 1971. A summary of this investment, by function, is indicated in Table 6-1.

Table 6-1. Hetch Hetchy Project Original Cost (Approximate) as of June 30, 1971

Function	Original cost, millions of dollars	Percent
Water	91	33
Power	79	29
Joint	105	38
Total	275	100

Approximately 33 percent of the capital costs of the system are directly assignable to the water supply function and another 29 percent are directly assignable to the power-generation function.

The remaining 38 percent of the capital costs are associated with dual-purpose facilities, which to a significant degree support both the water supply function and the power generation function. However, the relative degree to which power and water will benefit from a joint facility can vary considerably, depending on the specific usage of the joint facility.

Total project expenditures in fiscal year 1969-1970 (previously detailed in Table 4-2) are again summarized in Table 6-2. Approximately 39 percent of the annual net costs were "Joint" expenditures, which benefitted both the power and water functions.

In the Hetch Hetchy Project as it exists today, there are essentially two distinct "Joint" cost allocations that must be determined:

(1) New Don Pedro Joint Costs. (These consist of the bond interest and bond redemption costs associated with the New Don Pedro Reservoir).

(2) All other Hetch Hetchy Project Joint costs, excluding the New Don Pedro. (These consist of the Joint operating expenses and the Joint capital costs other than Don Pedro Debt Service).

Table 6-2. Total Hetch Hetchy Project Expenditures in Fiscal Year 1970, dollars

Description	Power	Water	Joint	Total
Total expenditures	9,418,400	2,622,200	4,928,500	16,969,100
Less: Wheeling charges	(2,273,200)	0	0	(2,273,200)
Purchased power	(302,800)	0	0	(302,800)
Muni transit overhead lines	(1,750,300)	0	0	(1,750,300)
Line rental	(54,000)	0	0	(54,000)
Net expenditures	5,038,100	2,622,200	4,928,500	12,588,800
Percent	40%	21%	39%	100%

For purposes of determining the annual Hetch Hetchy Assessment to the SFWD, both of these joint costs must be allocated equitably between power and water.

Because such a substantial share of the project costs concern joint functions, an improper allocation of such costs could result in the inadvertant subsidy of water by power, or visa-versa.

In order to make the assignments as equitable as possible, it is proposed that the "proportional benefits" method of cost-allocation be employed.

Proposed Method of Cost-Allocation

The aim of equitable cost-allocation is to cause each function, water and power, to bear its fair share of the costs it generates.

Because of the uniqueness of each multiple-purpose water resource project, it is virtually impossible to develop a single method of cost-allocation for universal application. However, the following general procedure is common to almost all accepted methods:

(1) Isolate the specific costs ..... those that are directly assignable to either the water function or the power function.

(2) Allocate the remaining "Joint" costs equitably between the two functions, in proportion to the relative benefits that will accrue to each function.

In a dual-purpose project, the costs incurred by a joint facility cannot be physically identified with either of the vendible project purposes. At the same time, the proportionate share of the benefits accruing to power and water are likely to differ for each joint project facility. It would be equitable if the costs incurred by each joint facility could be allocated between water and power in the same proportion as the relative benefits attributable to that project facility.

Consistent with this objective, the Federal government has adopted the "Separable Costs-Remaining Benefits" method of cost-allocation for multi-purpose water resource projects. This method is utilized by the Corps of Engineers, the Bureau of Reclamation and the Federal Power Commission, where multi-purpose projects include both vendible purposes (power, irrigation water, domestic water) and non-vendible purposes (flood control, recreation, stream fisheries, navigation, land reclamation).

In this method, joint costs are allocated to both vendible and non-vendible project purposes by a complex procedure which requires detailed cost analyses of hypothetical alternative projects in order to be effective, as well as the calculation of theoretical "alternative costs".

The Assembly Interim Committee on Water Problems, in their February 1, 1960 majority report on "Economic and Financial Policies for State Water Projects", recommended against using the standard "Separable Costs-Remaining Benefits" method of cost-allocation for California water projects.

The following excerpt (from page 25 of their Report) outlines their main objection to the standard "Separable Costs-Remaining Benefits" method, and their alternative recommendation:

> "Finally any use of benefits lacks the economic validity which can be secured when revenues are used. The separable costs-remaining benefits method is an improvement over many previously used methods of cost allocation but it is obviously not the tool needed in California to balance costs and revenues.
>
> A simpler and sounder method for California to use in allocating costs can be constructed from the separable costs-remaining benefits method, if instead of using benefits, the joint costs are distributed on the basis of revenues".

The "Separable Costs-Remaining Benefits" technique of cost-allocation is subject to considerable variation in judgement and method, which can produce widely differing results for the same multiple-purpose project. The Assembly Water Committee therefore recommended a modification of the concept that would distribute joint costs on the basis of revenues, rather than on the basis of theoretical benefits.

This modification is particularly appropriate in the case of Hetch Hetchy, where joint use is made of land, reservoirs, and tunnels by only two project functions, both of which are vendible. It provides the common denominator which permits both functions to be measured on a comparable basis.

However, an attempt to distribute joint costs on the basis of revenues may create two further problems:

1. In a hydroelectric project, the power plant generally produces full revenues almost immediately after completion of construction, whereas excess non-revenue producing capacity is provided in the water supply system to meet an estimated demand many years in the future.

2. In the Assembly Water Committee minority report dissent, (page 56 of their Report), the following pertinent and valid objection was raised:

> "The purpose of a cost allocation is to provide a basis for charging prices which will produce sufficient revenues to pay the allocated cost. If you must determine first revenues that would be paid by purchasers willing and able to pay in order to determine your cost allocation, then what is the need of a cost allocation, since you have already determined what the purchasers are going to pay".

The "Proportional Benefits" method of cost allocation specifically proposed for the Hetch Hetchy Project does employ the revenue modification recommended in the majority report, but it has also been designed to circumvent the two problems cited above. It is proposed because it appears to be more equitable than any of the alternative methods.

Description of "Proportional Benefits" Method of Cost Allocation

The Proportional Benefits method of cost-allocation can be readily applied to the Hetch Hetchy Project by utilizing the following procedure:

1. Determine the specific costs of the project, and assign them directly to the water or power functions.

2. Using actual recorded power revenues, determine the current average value of one Mwh of electricity (for information purposes, the annual average value of one Mwh of electricity over the last four years is shown in Table 6-3).

3. On the basis of the existing system relationships determine the "balancing" cost of one acre-foot of water, using the procedure described below. (For information purposes, actual recorded assessments and water deliveries to the SFWD for the past ten years are shown in Table 5-1).

4. Using the "balancing" cost for water and the current recorded average value of one Mwh of electricity, determine the total revenue-producing capability of the project for both the power and water functions at the anticipated project capability over the next five years, (234,000 acre-feet; 1,943,000 Mwh), per Fig. 5-1 and Table 3-2.

5. Allocate the joint operating expenses and capital costs between water and power, for the total project excluding New Don Pedro debt service, in proportion to the total revenue-producing capability of each function, as shown on page 32.

6. Allocate the current bond interest and bond redemption costs associated with the New Don Pedro Project, by using the identical procedure as described above. (However, the comparative revenue-producing capacity of this joint facility, and the applicable allocation percentages, must be separately determined as described on page 33).

7. Determine the appropriate annual assessment to the SFWD. This will be equal to the total of the specific water costs, the water share of the joint operating and capital costs, and the water share of the New Don Pedro debt service.

8. In addition, the appropriate annual assessment to the SFWD should also be approximately equal to the product of the "balancing" cost per acre-foot of water times the annual quantity of water delivered to the SFWD.

Table 6-3. Hetch Hetchy Project Power Revenues, Fiscal Years 1968 through 1971

Fiscal year	Generated power (MWH), less losses	Gross operating revenues, dollars	Wheeling charge, purchased power, and line rental, dollars[d]	Net operating revenues, dollars	Net revenue per MWH, dollars[c]
1968[a]	1,763,014	12,856,531	(2,297,261)	10,559,270	5.99
1969	1,907,081	13,230,264	(2,802,700)	10,427,564	5.47
1970[b]	1,883,523	14,090,231	(2,629,973)	11,460,258	6.08
1971	1,937,111	14,981,938	(2,997,202)	11,984,736	6.19

[a] 1968 was the first full year of operation for the new Robert C. Kirkwood Powerhouse.
[b] 1970 was the first full year of operation for the new Moccasin Powerhouse.
[c] The average net revenue per MWH for 1970 and 1971 combined was $6.14.
[d] Purchased power results in a "wash" sale, as the purchase cost is substantially the same as the selling price, on the average.

Balancing Cost

The balancing cost per acre-foot of water is the only cost which simultaneously accomplishes all four of the following objectives.

It is that cost per acre-foot of water which:

1. results in the proposed annual Hetch Hetchy assessment to SFWD, when multiplied by the annual quantity of water delivered to SFWD.

2. derives the applicable allocation factor for the water share of the New Don Pedro debt service, on the basis of proportional benefits.

3. derives the applicable allocation factor for the water share of the remaining Hetch Hetchy joint operating and capital expenses, on the basis of proportional benefits.

4. results in a proposed annual assessment to SFWD that is also equal to the total of: (the specific water expenses) + (the water share of the New Don Pedro debt service expenses) + (the water share of the remaining joint operating and capital expenses).

Balancing Cost Formula

To determine the value of "X", (the "balancing" cost per acre-foot of water), using recorded data for fiscal year 1969-1970, it was necessary to simultaneously solve for the following:

Allocation Factor for Water Share of Joint Operating and Capital Expenses:

$$\frac{(234,000)\ (X)}{(234,000)\ (X)\ +\ (11,930,020)} = Y$$

Allocation Factor for Water Share of New Don Pedro Debt Service:

$$\frac{(84,150)\ (X)}{(84,150)\ (X)\ +\ (921,000)} = Z$$

1969-1970 Equitable Assessment to SFWD:

$$(205,798)\ (X) = (3,042,900) + (Y)\ (1,093,900) + (Z)\ (2,865,300)$$

The "balancing" cost per acre-foot of water delivered by Hetch Hetchy to the SFWD in fiscal year 1969-1970 was found to be $26.25.

The allocation factor for the water share of the joint operating and capital expenses is 33 percent, as calculated on page 32.

The allocation factor for the water share of the New Don Pedro Debt Service is 70 percent, as calculated on page 33.

The 1969-1970 equitable assessment to the SFWD was found to be $5,400,000, in accordance with the formula shown above.

Average Value of a Mwh of Electricity

A composite cost of $6.14 was used in the applicable cost allocation equations as the average value per Mwh of electricity, as determined in Table 6-3. Fiscal years 1969-1970 and 1970-1971 are the first two full years of project operation that include both the new Moccasin powerhouse and the new Kirkwood powerhouse. Under the present philosophy of powerhouse operation, Kirkwood is operated as base-load plant and Moccasin is operated as a peaking plant.

Holm may be operated either as a base-load or peaking plant, as desired.

In actual practice, there are a variety of rate schedules for the sale of power and energy, each applicable to a particular class of customers. There are separate rate schedules for the chemical and industrial customers; for Riverbank; for the irrigation districts; and for the municipal customers.

By maximizing the sale of on-peak power, the average annual value per Mwh of electricity has been enhanced during the past two years, and $6.14/Mwh represents the current composite annual average value.

Allocation Formula for Hetch Hetchy Project Joint Operating and Capital Costs

The average annual delivery of electricity over the next five years is 1,943,000 Mwh, per Table 3-2. (This is equivalent to 221,800 kw of capacity operating continuously).

The present project configuration is expected to remain unchanged for at least the next five years, and probably longer.

There are no immediate plans for further power development in the forseeable future. Also, construction of a fourth San Joaquin Pipeline is not scheduled until the next decade.

The total annual revenues from the project over the next five years will therefore average as follows:

Water:	208.6 mgd x 1,122 acre-feet/year/mgd = 234,000 acre-feet
	234,000 x $26.25 = $6,142,500
Power:	221,800 KW x 8,760 hours/year = 1,943,000 mwh
	1,943,000 x $6.14 = $11,930,020
Total:	$6,142,500 + $11,930,020 = $18,072,520
% Water:	$6,142,500 ÷ $18,072,520 = 33%
% Power:	$11,930,020 ÷ $18,072,520 = 67%

On the basis of the "Proportional Benefits" method of cost-allocation, the joint operating and capital expenses (excluding New Don Pedro debt service) should be allocated in the proportion of 67 percent to Power and 33 percent to Water.

However, a separate analysis is necessary for the New Don Pedro Dam, in order to equitably allocate Bond Interest and Bond Redemption for that development.

Allocation Formula for New Don Pedro Debt Service

The 1968-69 Report of the Public Utilities Commission of the City and County of San Francisco stated the following, in the Hetch Hetchy chapter which describes the New Don Pedro Dam:

> "The City will thus be in a position to increase its high mountain storage to 1,395,000 acre feet, enough to increase diversions of water to San Francisco by 190 million gallons daily - for a daily capacity of 400 million gallons".

The safe, sustained average production capability of the Hetch Hetchy Project before the New Don Pedro Dam was thus conservatively estimated to be 210 mgd, (400 mgd - 190 mgd).

The 1966-1967 Annual Report of the Hetch Hetchy Department (on page 7) stated the following, with respect to the transmission capability of the new San Joaquin Pipeline No. 3:

> "Upon completion of all the described work, the capacity of the Hetch Hetchy Aqueduct across the San Joaquin Valley will be increased from 220 million gallons per day to about 300 million gallons per day".

The Public Utilities Commission Report of September, 1967 entitled "San Francisco Water and Power" states (on page 28) that the "total capacity of the pipelines is 295 million gallons per day". This same report (on page 30) states that the coast range tunnel is "able to handle over 275 million gallons" daily.

For the purpose of allocating the New Don Pedro bond interest and redemption costs, the prior capability of the project was assumed to be 215 mgd. The safe, sustained transmission capability of the aqueduct with three pipelines, in conjunction with the existing coast range tunnel, was assumed to be 290 mgd.

Therefore, the immediate effect of the New Don Pedro Dam (pending the construction of a fourth San Joaquin Valley pipeline) was to increase the production and transmission capabilities of the existing water system by 75 mgd.

It effectively increased the capacity of the existing power system by approximately 150,000 Mwh, per Bechtel's analysis, (adjusted for the new Moccasin Powerhouse), as previously described in Chapter 3.

The comparative revenue-producing capability of this facility is therefore as follows:

Water:	75 mgd x 1,122 acre-feet/year/mgd = 84,150 acre-feet
	84,150 x $26.25 = $2,208,938
Power:	150,000 Mwh x $6.14 = $921,000
Total:	$2,208,938 + $921,000 = $3,129,938
% Water:	$2,208,938 ÷ $3,129,938 = 70%
% Power:	$921,000 ÷ $3,129,938 = 30%

Power revenues will benefit fully from the New Don Pedro Reservoir almost immediately. However, based on current projections, it will take approximately 15 years before water revenues benefit fully from New Don Pedro.

On the basis of the "Proportional Benefits" Method of Cost-Allocation, the debt-service costs attributable to the New Don Pedro Dam should be allocated in the proportion of 30 percent to Power and 70 percent to Water.

Effect of "Proportional Benefits" Method of Cost-Allocation for Test Year 1970

The annual assessment to the San Francisco Water Department in Fiscal Year 1969-1970 was $2,500,000, or approximately $12.15 per acre-foot for the actual quantity of Hetch Hetchy water delivered, (205,798 acre-feet).

Table 6-4. Calculation of SFWD Assessment at Cost, for Fiscal Year 1970, dollars

Description	Specific cost	Water-share of joint cost	Total cost
Bond interest	986,600	1,064,000	2,050,600
Bond redemption	1,457,700	941,700	2,399,400
Equipment, additions and replacements	0	227,000	227,000
Taxes	0	193,700	193,700
Operating expenses	177,900	364,600	542,500
Total	2,622,200	2,791,000	5,413,200

Using the "Proportional Benefits" method of cost-allocation, the annual assessment would have been substantially greater, as indicated in Table 6-4.

It appears that an equitable annual assessment should have been approximately $5,400,000, ($26.25 per acre-foot), for fiscal year 1969-1970, rather than $2,500,000, which was less than the specific water costs alone.

Recommendation for Future

Future annual assessments to the SFWD should be developed by applying the "Proportional Benefits" method of cost-allocation to the budgeted expenditures of the Hetch Hetchy Department.

The allocation factors for the project as a whole and for the New Don Pedro Reservoir should be re-computed every five years, for the purpose of determining the equitable annual assessments to the SFWD.

CHAPTER 7

PROPOSED FUTURE ASSESSMENTS TO SFWD

The "proportional benefits" method of cost allocation was used in allocating the joint costs between power and water, to develop the recommended future assessments to SFWD for the next five years.

The recommended future assessments represent the total of the specific water costs, plus the water share of the "joint" costs, for debt service, capital expenditures, taxes, operating and maintenance expenses.

Debt Service

Annual debt service for the total Hetch Hetchy Project has been indicated in Table 7-1 for fiscal years 1971-1972 through 1976-1977, based on the issues outstanding at the present time.

Table 7-1. Debt Service for Hetch Hetchy Project, 1972 through 1977

Fiscal year	1972	1973	1974	1975	1976	1977
Bond interest						
1928 issue (all water)	175,500	148,500	121,500	94,500	67,500	40,500
1955 issue (all power)	615,650	519,687	448,488	377,575	306,588	234,587
1961 issue (S.J. Pipeline #3)	557,647	543,556	500,365	454,941	410,881	370,282
1961 issue (New Don Pedro Res.)	1,566,500	1,504,100	1,424,800	1,328,600	1,232,400	1,136,200
Total	2,915,297	2,715,843	2,495,153	2,255,616	2,017,369	1,781,569
Bond redemption						
1928 issue (all water)	600,000	600,000	600,000	600,000	600,000	600,000
1955 issue (all power)	3,215,000	2,340,000	2,340,000	2,340,000	2,345,000	2,345,000
1961 issue (S.J. Pipeline #3)	966,471	1,123,623	1,175,479	1,175,483	1,175,482	1,177,055
1961 issue (New Don Pedro Res.)	1,200,000	1,200,000	2,600,000	2,600,000	2,600,000	2,600,000
Total	5,981,471	5,263,623	6,715,479	6,715,483	6,720,482	6,722,055
Total debt service	8,896,768	7,979,466	9,210,632	8,971,099	8,737,851	8,503,624

Note: The effect of the additional sale of 1961 Series Bonds in January, 1972, may be to increase the water share of debt service for the Hetch Hetchy Project by approximately $80,000 per year.

Using the allocation factors developed in Chapter 6, the water share of the annual debt service is shown in Table 7-2.

Table 7-2. Water Share of Debt Service for Hetch Hetchy Project, 1972 through 1977

Fiscal year	1972	1973	1974	1975	1976	1977
Bond interest						
1928 issue	175,500	148,500	121,500	94,500	67,500	40,500
1961 issue (S.J. Pipeline #3)	557,647	543,556	500,365	454,941	410,881	370,282
(70%) 1961 issue (New Don Pedro Dam)	1,096,550	1,052,870	997,360	930,020	862,680	795,340
Total	1,829,697	1,744,926	1,619,225	1,479,461	1,341,061	1,206,122
Bond redemption						
1928 issue	600,000	600,000	600,000	600,000	600,000	600,000
1961 issue (S.J. Pipeline #3)	966,471	1,123,623	1,175,479	1,175,483	1,175,482	1,177,055
(70%) 1961 issue (New Don Pedro Dam)	840,000	840,000	1,820,000	1,820,000	1,820,000	1,820,000
Total	2,406,471	2,563,623	3,595,479	3,595,483	3,595,482	3,597,055
Total debt service (water)	4,236,168	4,308,549	5,214,704	5,074,944	4,936,543	4,803,177

Capital Expenditures

The annual capital expenditures funded from revenues have been indicated in Table 7-3 for fiscal years 1965-1966 through 1970-1971.

Table 7-3. Hetch Hetchy Project Capital Expenditures Funded from Revenues, dollars

Fiscal year	Equipment	Additions and betterments	Reconstruction and replacements	Moccasin diversion conduit	Total capital expenditures	Estimated water share
1966	42,460	1,200	3,677,652	0	3,721,312	70,000
1967	40,810	92,225	2,232,486	0	2,365,521	390,000
1968	66,134	99,340	528,207	2,000,000	2,693,681	2,231,000
1969	85,884	231,715	608,035	0	925,634	309,000
1970	74,213	286,080	321,172	0	681,465	227,000
1971	94,074	495,849	568,329	0	1,158,252	372,000
1972	70,000	382,000	763,000	0	1,215,000	405,000
1973	74,000	400,000	801,000	0	1,275,000	425,000
1974	78,000	419,000	838,000	0	1,335,000	445,000
1975	82,000	438,000	875,000	0	1,395,000	465,000
1976	86,000	456,000	913,000	0	1,455,000	485,000
1977	90,000	475,000	950,000	0	1,515,000	505,000

The estimated water share was determined by reviewing each individual project and combining the water share of the joint project costs with the total costs of the specific water projects.

The estimated annual capital expenditures for the next five years were determined by extrapolating the trend of past expenditures, and incorporating a suitable escalation factor.

No extraordinary expenditures, (e.g. the Moccasin diversion conduit) are anticipated during the foreseeable future.

Taxes

Taxes in 1969-1970 on Hetch Hetchy properties located outside of San Francisco totaled $322,828, as shown in Table 7-4.

Table 7-4. Property Taxes Paid by Hetch Hetchy in Fiscal Year 1970, dollars

Tax-levying body	Assessed value	Total amount of taxes paid
Alameda County	1,500	145
San Joaquin County	27,600	2,723
San Mateo County	2,490	244
Stanislaus County	80,750	8,062
Tuolumne County	3,938,659[a]	310,550
Banta-Carbona Irrigation District	3,192	152
Oakdale Irrigation District	12,320	862
West Stanislaus Irrigation District	1,800	90
Total	4,068,311	322,828

[a] Includes $3,193,060 assessment for water rights

Based on the specific location and function of the various properties, 60 percent of the taxes are allocated to water and 40 percent are allocated to power.

The water share of past property taxes, as well as the estimated future property taxes, are summarized on page 39.

Operating Expenses

The actual recorded operating and maintenance expenses assigned to water in fiscal years 1965-1966 through 1968-1969 are indicated in Table 7-5. These are the specific expenses assigned to water, plus 20 percent of the joint expenses. However, the operating and maintenance expenses indicated in Table 7-5 for 1969-1970 have been normalized and amended to include the specific expenses assigned to water plus 33 percent of the joint expenses, in accordance with the cost allocation factors derived in Chapter 6.

The operating and maintenance expenses projected for 1970-1971 through 1976-1977 were determined by extrapolating the trend of past expenditures, adjusting for inclusion of 33 percent of the joint expenses instead of 20 percent and incorporating a suitable escalation factor. These projected expenses are also indicated in Table 7-5.

Table 7-5. Water Share of Hetch Hetchy Operating and Maintenance Expenses, dollars

Description	1966[a]	1967	1968	1969	1970[b]	1971[c]	1972	1973	1974	1975	1976	1977
Operating expenses												
Hydraulic power generation expense	15,520	15,894	16,167	19,332	20,317	19,000	18,000	17,000	16,000	15,000	14,000	13,000
Transmission expense	55,420	32,961	32,057	30,783	43,012	38,000	37,000	36,000	35,000	34,000	33,000	32,000
Administrative and general expense	165,663	172,857	211,355	244,997	246,744	267,000	282,000	297,000	312,000	327,000	344,000	360,000
Total operating expense	236,603	221,712	259,579	295,112	310,073	324,000	337,000	350,000	363,000	376,000	391,000	405,000
Maintenance expenses												
Hydraulic power generation expense	40,972	38,955	41,131	62,663	49,960	55,000	61,000	67,000	73,000	79,000	85,000	90,000
Transmission expense	52,297	39,539	54,354	60,639	79,435	97,000	115,000	133,000	151,000	169,000	186,000	204,000
Administrative and general expense	40,784	46,857	49,628	53,259	92,995	96,000	100,000	104,000	108,000	112,000	115,000	119,000
Total maintenance expense	134,053	125,351	145,113	176,561	223,390	248,000	276,000	304,000	332,000	360,000	386,000	413,000
Raker Act fee	6,000	6,000	6,000	6,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Total operating and maintenance expenses	376,656	353,063	410,692	477,673	542,463	582,000	623,000	664,000	705,000	746,000	787,000	828,000

[a] 1966 through 1969 expenses are the actual recorded expenses as taken from the annual income statements
[b] 1970 expenses have been amended to include 33 percent of the joint expenses, rather than 20 percent
[c] 1971 through 1977 expenses are projections which include 33 percent of the joint expenses and a suitable escalation factor

Proposed Future Assessments to SFWD for Fiscal Years 1972-1973 Through 1976-77

The proposed annual assessments to SFWD from Hetch Hetchy are indicated in Table 7-6, and are equal to the sum of the costs projected for the water function of the project.

The proposed annual assessments for the five years 1972-1973 through 1976-1977 inclusive are as follows:

Fiscal year	Assessment to SFWD, dollars
1973	5,625,000
1974	6,602,000
1975	6,534,000
1976	6,468,000
1977	6,406,000
Average	6,327,000

Table 7-6. Proposed Annual SFWD Assessment from Hetch Hetchy, at Cost, dollars

Description	1966	1967	1968	1969	1970	1971
Bond interest (excluding 1961 issue)	459,000	401,000	343,000	286,000	243,000	207,000
Bond redemption (excluding 1961 issue)	1,882,000	1,617,000	1,617,000	1,068,000	800,000	700,000
Bond interest (1961 S.J.P. #3)	(208,000)	417,000	510,000	540,000	572,000	552,000
Bond redemption (1961 S.J.P. #3)	(187,000)	366,000	709,000	748,000	803,000	825,000
Bond interest (70% x 1961 NDP)	0	0	564,000	1,228,000	1,184,000	1,140,000
Bond redemption (70% x 1961 NDP)	0	0	0	840,000	840,000	840,000
Total bond interest	251,000	818,000	1,417,000	2,054,000	1,999,000	1,899,000
Total bond redemption	1,695,000	1,983,000	2,326,000	2,656,000	2,443,000	2,365,000
Total debt service	1,946,000	2,801,000	3,743,000	4,710,000	4,442,000	4,264,000
Equipment, reconstruction and replacement, and additions and betterments	70,000	390,000	2,231,000	309,000	227,000	372,000
Taxes	149,000	178,000	190,000	188,000	194,000	205,000
Operating expenses (specific, plus assigned share of joint)	377,000	353,000	411,000	478,000	543,000	582,000
Annual total	2,542,000	3,722,000	6,575,000	5,685,000	5,406,000	5,423,000

Description	1972	1973	1974	1975	1976	1977
Bond interest (excluding 1961 issue)	175,000	148,000	122,000	94,000	67,000	40,000
Bond redemption (excluding 1961 issue)	600,000	600,000	600,000	600,000	600,000	600,000
Bond interest (1961 S.J.P. #3)	558,000	544,000	500,000	455,000	411,000	370,000
Bond redemption (1961 S.J.P. #3)	966,000	1,124,000	1,175,000	1,175,000	1,175,000	1,177,000
Bond interest (70% x 1961 NDP)	1,097,000	1,053,000	997,000	930,000	863,000	795,000
Bond redemption (70% x 1961 NDP)	840,000	840,000	1,820,000	1,820,000	1,820,000	1,820,000
Total bond interest	1,830,000	1,745,000	1,619,000	1,479,000	1,341,000	1,205,000
Total bond redemption	2,406,000	2,564,000	3,595,000	3,595,000	3,595,000	3,597,000
Total debt service	4,236,000	4,309,000	5,214,000	5,074,000	4,936,000	4,802,000
Equipment, reconstruction and replacement, and additions and betterments	405,000	425,000	445,000	465,000	485,000	505,000
Taxes	216,000	227,000	238,000	249,000	260,000	271,000
Operating expenses (specific, plus assigned share of joint)	623,000	664,000	705,000	746,000	787,000	828,000
Annual total	5,480,000	5,625,000	6,602,000	6,534,000	6,468,000	6,406,000

APPENDIX A

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